PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES.

WEDNESDAY, MARCH 29TH, 1916.

The Forty-first Annual General Meeting, and the Ordinary Monthly Meeting, were held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, March 29th, 1916.

ANNUAL GENERAL MEETING.

Mr. A. G. Hamilton, President, in the Chair.

The Minutes of the preceding Annual General Meeting (March 31st, 1915) were read and confirmed.

The President delivered the Annual Address.

PRESIDENTIAL ADDRESS.

Bacon's familiar essay on "Adversity" concludes with this incontestable aphorism: "For prosperity doth best discover vice; but adversity doth best discover virtue." Twenty months ago, a lengthy period of unprecedented, material world-prosperity, largely due to Man's increased control of Nature, suddenly ended in discovering the calamitous condition of things which still confronts the world—Civilisation attacked from within, divided against itself, the solidarity of mankind rent in twain, Internationalism bankrupt. The case has been clearly and simply stated in a recent article by Emeritus Professor G. T. Ladd, of Yale University, in these words—"To-day, the German mind is at wide variance, is at desperate odds, with the human mind. It appears as either superhuman or below the human. It is not in accord with the standards supplied by the great majority of

civilised and conspicuously thought-directed mankind."* Here is outlined the situation to be saved. If Civilisation is to continue and progress, it is unthinkable that it cannot be saved. What, except adversity, can be expected to discover the virtue required to save it? The ruinous expenditure in lives and treasure is impoverishing all the belligerent nations in varying degrees. The tide of adversity is steadily rising for all concerned in the war, though the full effect may not be fully realised until the heat of warfare has subsided. The possible failure of ambitious schemes, on one side, may enhance the general effect.

It might be expected, perhaps, that the recruiting-officer would be likely to look askance at most of the members of a Scientific Society. Nevertheless, ten of our limited number have responded to the call to arms. Some of them are "Anzacs"; others are on the way to destinations unknown to us; two have returned, one of them temporarily, while several are in training. It is befitting that we should have them in mind at this, our annual gathering. They are entitled to our warmest regard and good wishes, and to anything that we can do to show our appreciation of their readiness to serve the nation, and to strive for the triumph of the great issues at stake. Therefore, as a tribute of respect to them, I will ask Members to rise in their places while I read the list of names; and when I have concluded, to join with me in saying "All honour to our Soldier-Members!"

Aurousseau, Marcel, B.Sc., University of West Australia.

Bretnall, Reginald Wheeler, Australian Museum.

Carne, Walter Mervyn, Botanical Gardens, Sydney.

David, Professor T. W. Edgeworth, C.M.G., D.Sc., F.R.S., University of Sydney.

Ferguson, Eustace W., M.B., Ch.M., Department of Public Health.

Fry, Dene B., University student.

Goldfinch, Gilbert M., served at Gallipoli.

Henry, Max, M.R.C.V.S., on service abroad.

* "The Human Mind *versus* the German Mind." Hibbert Journal, January, 1916.

Laseron, Carl F., Technological Museum, Sydney: wounded at Gallipoli.

Stokes, Edward S., M.B., Ch.M., returned after service abroad: now P.M.O.

Sir Douglas Mawson is on the eve of leaving for England to enter upon military service. Dr. R. Broom, a Corresponding Member, has joined the Army Medical Service; but whether in South Africa or in Europe is not known to us.

If, as individuals, we are in need of further provocation to seriousness, we may surely find it in the departure of Professor David for the front with the Mining Battalion. We may well be impressed by his earnestness and self-sacrificing action in a great crisis; and be led to appreciate the example which he has set.

It was something more than a mere formality that, at a Special General Meeting held on 30th June, 1915, on the motion of the Hon. Treasurer, it was heartily and unanimously resolved "That the Annual Subscriptions of all Ordinary Members of the Society serving with the Australian Expeditionary Forces be remitted during their term of service."

Considering the unfavourable and depressing conditions entailed by the continuance of the war, the Society's progress during the past year may be regarded as satisfactory.

The full effect of the war on our exchange-relations with European Scientific Societies and Institutions is now realisable. For the Session 1914-15, the total number of donations and exchanges received amounts to 1028 additions to the library, as compared with 1166 for 1913-14 (five months of which were war-months), and 1285 for 1912-13, before the war. The significance of the shortage is, that our communications with over forty Societies, from which, under normal conditions, we hear at least once during the year, have been completely suspended. In some cases, we have received official notification that, in consequence of the disturbance of mails or other means of transmission, it has been deemed advisable to keep back despatches for the present.

The fortieth volume of the Proceedings for 1915 (896 pp., and

59 plates) has been completed in good time, and distributed, as far as circumstances permit. It contains thirty-six papers, on a wide range of subjects, read at the Meetings during the Session.

The recent decision of the Postal authorities that the annual volumes of the Society's Proceedings are not to be regarded as "books" within the meaning of the Postal regulations, and cannot be sent at book-rates per book-post, but are to be treated as "Printed Matter," and charged on a higher scale, on the technical ground that one Part of each volume contains a balance-sheet and report, means a substantial increase in postage on our publications for Societies, Institutions, and individuals within the Commonwealth, which cannot be delivered by messenger. The decision applies also to the publications of Australian Scientific Societies and Institutions generally, to University Calendars, and to the Annual Reports of Government Departments. Two examples will show that the cost is almost or quite quadrupled. The postage on single copies of the four Parts of last year's Proceedings, as "Printed Matter," was 1s. 3d. [one Part at 4½d., three Parts at 3½d. each]. Per Book-post, the amount would have been 4½d. [one Part at 1½d., three Parts at 1d. each]. We have recently received the last Calendar of the University of Melbourne, as Printed Matter charged 8d., whereas at book-rates the postage would have been 2d. The Annual Reports of mercantile Companies or Institutions are not volumes of 800-900 pages, with from 40-90 Plates illustrating objects of scientific interest only; so that the increase in cost falls most heavily on Scientific and Educational organisations. Considering that the balance-sheets and reports of Scientific Societies, like those of Educational, Charitable, and Government Institutions, are not records of profits made, and dividends payable: and often, as in our case, are largely concerned with the administration of trust-funds, this increase in the cost of sending scientific publications by mail—much higher than is charged on exactly similar publications containing balance-sheets, etc., which come to us per book-post at book-rates from other distant countries—seems rather like a tax on the diffusion of knowledge of scientific and

educational value, and, as such, is objectionable. Two deputations of representatives of Scientific Societies and Institutions at different times since the new decision came into force, have waited on the Minister of the Department, but without result. In response to a request, Mr. J. E. West, Member for West Sydney in the House of Representatives, most kindly and courteously took some trouble to understand the Council's views on the subject, and was good enough to lay them before the Postal authorities. As matters stand at present, a new Postal Bill is in contemplation, which will provide for increases in certain rates, including book-postage; but as it is to be a measure for providing for a decreased revenue in war-time, we shall have to make the best of it. Nevertheless, we want to see the definition of "books" revised. Under existing circumstances, it does not seem to be a trivial protest to make, that while works of fiction, for example, can be sent by book-post, the publications of Australian Scientific Societies cannot, on what are really merely technical grounds.

Five Ordinary Members were elected during the year, two resignations were received, and we have lost, by death, one Ordinary Member, and two of our senior Corresponding Members.

Mr. William Allan, of Wingham, was born at Cheltenham, England, in 1820; and had resided on the Manning River uninterruptedly since 1851. He was elected to Membership on February 24th, 1886. Mr. Allan, throughout his long life, evinced a keen interest in Natural History, especially in Ornithology and Entomology; and it was largely through his unceasing efforts that the "Wingham Brush" was reserved for the preservation of the native flora and fauna. In his younger days, he came to know John Gould, and was in the habit of visiting him in London. He was very highly esteemed in the Manning River district, in which he had resided so long, for his kindly disposition, and for his readiness at all times to take a prominent share in promoting the interests of the district and the welfare of its inhabitants. Mr. Allan passed away on April 25th, 1915, in his 95th year.

Charles W. De Vis, M.A., Curator of the Queensland Museum for a number of years, died in Brisbane in April, 1915. Mr. De Vis, though somewhat later in the field than his colleague, in his official capacity, tried to do for the Queensland fauna, what Mr. Bailey did for the flora, but under more unmanageable and difficult conditions; for the zoological species far outnumber the botanical species, and the zoologist has no comprehensive, self-contained monograph like the Flora Australiensis to serve as a basis for his work. Both were pioneers in a local effort to provide, study, and record collections, illustrative of the fauna and flora of the same State and for State purposes; and they both encountered the usual preliminary difficulties, when such enterprises are in the early stages of development. Almost all Mr. De Vis' numerous papers on the vertebrates, fossil or recent, of Queensland and New Guinea, are to be found in the Proceedings of this Society (forty, contributed during the years 1882-95), in the Proceedings of the Royal Society of Queensland, in the Annual Reports on British New Guinea, 1889-97, published in Brisbane, or in the Annals of the Queensland Museum(1892-1911). By the aid of the "List of Contributors to the first Series of the Society's Proceedings" [21 titles listed; 19 others in Proceedings, 1886-1895]; of Dr. Shirley's "International Catalogue of Scientific Literature: Queensland Volume"(1889) [18 titles under Palæontology; 49 under Zoology]; and of the recently published "Index to Vols. i.-xxv. of the Proceedings of the Royal Society of Queensland"(1914), his numerous papers can be readily found. For reasons mentioned, circumstances did not permit of his issuing collected results, as his botanical colleague was able to do. Mr. De Vis was elected a Corresponding Member of the Society in July, 1882. He had retired from active work for some years before his decease, on account of advancing age. It is remarkable that Queensland should lose the two veterans, whose work was carried on concurrently for so many years, not only in the same year, but within so short a time as a few weeks of each other. From the absence of biographical details, this notice is necessarily short.

Frederick Manson Bailey, C.M.G., Colonial Botanist of Queensland, the Society's senior Corresponding Member, elected on 26th November, 1877, whose long and active life came to an end on 25th June, 1915, was widely known and esteemed throughout Australia for his benevolence and simple-mindedness, as well as for his zeal as a botanist. He came from England to South Australia with his family, in 1839, a boy of twelve. Later on he spent some time at the goldfields in Victoria; then returned to Adelaide for a time, in 1853, migrated to New Zealand, where he remained for some years; and finally, he came back to Australia in 1861, and settled in Queensland. For a time, he engaged in private business in Brisbane. In 1875, he accepted the position of botanist to a Board appointed to deal with the diseases of plants and animals; this was his first official connection with Australian botany. Later on, he took charge of the botanical section of the Queensland Museum, until, in 1881, he was promoted to the position of Colonial Botanist. He was then able to devote himself in earnest to systematic collecting, and to the study and revision, from personal knowledge, of the Queensland flora. This he carried out exhaustively during the rest of his life, so that, as his last illness was very brief, he died in harness, in his 89th year. Queensland had attained the status of a separate Colony in 1859, only about two years before Mr. Bailey arrived, and its total population was about 30,000. Hence he was practically an eyewitness of its evolution, and his botanical work developed with its expansion. The flora soon attracted his attention, but scientific enterprises in Queensland were in their infancy; and, until the Flora Australiensis (1863-78) was completed, his progress in doing effective work was somewhat retarded. His first contribution to a knowledge of the Queensland flora was a modest, private venture, entitled "Handbook to the Ferns of Queensland: with xxii. Plates illustrative of Genera," published in 1874. As this made its appearance before the last volume of the Flora Australiensis was ready, it was republished in a rearranged and extended form, in 1881, following the classification of Bentham, under a new name, "The Fern

World of Australia." In the meantime, during the years 1877-81, eight papers, one of them "On the Flora of Stradbroke Island," appeared in the Proceedings of this Society[Vols. ii.-vi.]; in addition to two written in collaboration with the late Rev. J. E. Tenison-Woods, one of them entitled "A Census of the Flora of Brisbane"; the other "On some of the Fungi of New South Wales and Queensland"[Vols. iv.-v.]. His first official publication seems to have been a booklet entitled "Inquiry for Seeds of Grasses and other Fodder-Plants; with a List of the Grasses of Queensland"[12mo., Brisbane, 1877]. In this, he gave some particulars respecting the Board appointed by Parliament to inquire into diseases of live stock and plants; and signed himself, at the end, "Botanist to the Board." Mr. Bailey distributed his numerous publications liberally, and they are well known. With the aid of the "List of Contributors" to the first ten Volumes of our Proceedings[10 entries]; Dr. Shirley's Queensland Bibliography[54 entries up to 1899]; and the recently issued Index to Vols. i.-xxv. of the Proceedings of the Royal Society of Queensland, there is no difficulty in following up his work. After 1899, his most important productions were The Queensland Flora, in six Parts(1899-1902); The Weeds and Suspected Poison Plants of Queensland(1906); and The Comprehensive[illustrated]Catalogue of Queensland Plants, both Indigenous and Naturalised(1912). These three are, in reality, the collected and summarised results of all his work, though, up to the last, he continued his series of "Contributions to the Flora of Queensland," appearing in the Queensland Agricultural Journal, giving the results of any supplementary information available.

It is difficult to estimate the total number of the additions to the Queensland flora which Mr. Bailey was enabled to make, from the way in which he tabulated his results. Thus, in his Second Census(1889), Baron von Mueller gives the following numbers:—Vasculares: Australia, 1,409 genera, 8,839 species; Queensland, 3,753 species(42·5 per cent.). Mr. Bailey, in the Comprehensive Catalogue, includes the vascular with the other Cryptogams, and gives his results thus—Phanerogams of Queens-

land, 1,222 genera, 4,259 species with 437 varieties; naturalised species, 307. Cryptogams, 818 genera, 3,606 species with 283 varieties. From this it will be seen, that the species of Phanerogams alone outnumber the species of Vasculares given in the Baron's table by more than 500—a very substantial increase.

In his Presidential Address to the Royal Society of Queensland in July, 1891, entitled "Concise History of Australian Botany," Mr. Bailey gave an account of his early travels in search of Queensland plants, as well as of the collectors, who, from time to time, sent him material. He also makes some interesting references to his father, John Bailey, Colonial Botanist of South Australia, from whom he inherited his botanical tastes; and he explains how it was that, from the comparative poverty of the native flora of the Adelaide district, his father's energy naturally found more scope in horticulture than in botany, though he did not altogether neglect the native plants.

The "Handbook of Ferns," Mr. Bailey's earliest publication, was published in 1874. His last effort was the latest of the series entitled "Contributions to the Flora of Queensland," contained in Part 4 of Vol. iii., N.S. of the Queensland Agricultural Journal for April, 1915; so that his published work covers a period of more than forty years; but this embodies the results of fifty-four years' experience under conditions that were slowly altering. He enlisted the co-operation of specialists in some of the groups of Cryptogams, so that he was able to catalogue and furnish descriptions, and in many cases illustrations, of all the known Queensland plants, in an accessible form convenient for reference. By unwavering zeal, and unflagging industry, he completed the task he set himself, and he did it well. His memory deserves to be held in kindly remembrance, not only in Queensland, but by all who are interested in the progress of Australian botany. We have heard with satisfaction, that Mr. J. F. Bailey, who for a long time assisted his father, has been appointed to succeed him.

The decease of Mr. J. R. Garland, in February, 1915, some time after the arrangements for the elections to fill vacancies in

the Council for the Session, 1915-16 had been made, brought about an extraordinary vacancy, which was subsequently filled by the appointment of Mr. A. F. Basset Hull, who, in accordance with the provisions of Rule xv., governing such appointments, retires at this Meeting, but is eligible for re-election. From the foundation of the Society continuously up to the time of Mr. Garland's death, the Council had always included in its number one, and, for a great part of the period, two members of the legal profession interested in Science, who were most helpful in guiding the deliberations of the Council in matters submitted by, or to be referred to, the Society's Solicitors, or on obscure points which presented themselves unexpectedly, in connection with the administration of trusts. The appointment of Mr. Hull has restored the succession of such helpful members of Council.

As abstracts of the papers read during the year have been communicated to Members, and the papers themselves have been published, it is not necessary to refer to them in detail in offering a record of the Society's research-staff for the past year, as follows:—

Dr. R. Greig-Smith, Macleay Bacteriologist to the Society, continued his investigation of problems involved in the study of Soil-Fertility, and Nos. xiii., and xiv., of his series of papers on this subject were read during the year, and will be found in the last Part of the Proceedings. The first of these treats of the toxicity of soils; the second, of the stimulative action of chloroform retained by the soil. In addition, a third paper, in Part i., is descriptive of a new levangum-forming bacterium, which has been isolated and studied,

Dr. J. M. Petrie, Linnean Macleay Fellow in Biochemistry, completed two papers, one on the identification of the alkaloid of Native Tobacco, which will be read at the second Meeting of the coming Session; and the other, the third part of his study of hydrocyanic acid in plants. Other problems in hand are the statement of the results of the analyses of the inorganic constituents of plants; the photographic effects of the latex of *Euphorbia peplus;* the chemistry of the native Duboisias; and the alkaloids of *Solandra lævis.*

Mr. E. F. Hallmann, Linnean Macleay Fellow in Zoology, in continuation of his study of the Monaxonid Sponges, almost completed the examination of the *Axinellidæ*. A preliminary study of the Sponges brought back by the Australasian Antarctic Expedition received attention.

Mr. W. N. Benson, Linnean Macleay Fellow in Geology, continued his work on the geology and petrology of the Great Serpentine-Belt; and two papers, Parts iv., and v., of the series, dealing with the dolerites, spilites, and keratophyres of the Nundle district; and with the geology of the Tamworth district, were read during the year; and have appeared in Parts i. and iii. of the Proceedings for the year. The preparation of No. vi., treating of the intermediate region between the Nundle and Tamworth districts, and also a preliminary study of the Currabubula and Werris Creek areas were taken in hand, and some progress attained; but were subsequently suspended for special reasons. In August last, as a concession allowed during wartime, the Council granted Mr. Benson three months' leave of absence, afterwards extended up to the end of his term of appointment, in order to relieve Professor David of some of his University work, at first for national organisation at home, and later for military service abroad. The Council felt that the Society should cheerfully accept a share of the inconvenience and of the results of the disturbance of normal conditions arising in connection with the war. Mr. Benson will retire from his Fellowship at the end of his term, in order to continue the work which he has undertaken, during Professor David's absence. During his two years' connection with the Society as Fellow, Mr. Benson has carried out his work with both ability and zeal, and has amply justified his appointment. Throughout his work, he has had the great advantage of being in close touch with Professor David, whose experience and advice have always been freely available, both in the field, as well as in the laboratory. He has well advanced the subject he took in hand; and we hope that, when circumstances permit, he may be able to continue and

complete the important and promising work, which he has so well begun.

Mr. R. J. Tillyard, Linnean Macleay Fellow in Zoology, has completed his first year's work. Four papers have been submitted, two of which, on the rectal gills in the larvæ of Anisopterid Dragonflies, and the first of a series devoted to the study of Australian Neuroptera, were read during the year; and will be found in Parts ii., and iii., of the Proceedings for the year. The second and third of the series will be communicated at the first and third Meetings of the new Session.

For the third time, in October, 1915, the Council was able to offer four Fellowships, the full number. Five applications were received; and I have now the pleasure of making the first public announcement of the Council's reappointment of Dr. J. M. Petrie, Mr. E. F. Hallmann, and Mr. R. J. Tillyard to Linnean Macleay Fellowships in Biochemistry and Zoology; and of the appointment of Mr. H. S. Halcro Wardlaw, B.Sc., to a Linnean Macleay Fellowship in Physiology, for one year from 1st proximo; and, on behalf of the Society, of wishing for them favourable opportunities for carrying out their important work, with a very satisfactory measure of success.

In joining the Society's research-staff, Mr. Wardlaw does so with an excellent record, both as a student and as a Research Scholar of the University of Sydney. On graduating, in 1913, he obtained First Class Honours in Chemistry and Physiology, and was awarded the University Medal for Physiology. In the same year, he was appointed to a Science Research Scholarship, which he has held for two years, during which period a series of investigations were completed, the results of which are embodied in five papers, of which four have been communicated to the Royal Society of New South Wales; and one, on "The Temperature of Echidna," is to be found in our Proceedings for last year. A sixth paper is ready, and will be published in London. Mr. Wardlaw, as a Linnean Macleay Fellow, will continue and extend his work on the physiology of the secretion of milk and on problems which arise in connection therewith. As this is the

first time a physiologist has been appointed to a Fellowship, we look forward with pleasurable expectation to a more prominent place of this branch of science in the Society's Proceedings than has hitherto been possible.

The names of one Society and two Institutions—the National Academy of Sciences at Washington, the Zoological Museum at Tring, England, and the Instituto Oswaldo Cruz at Rio de Janeiro—have been added to the Society's Exchange-list during the year. The addition of their valuable publications to the library is very welcome.

Three portraits of workers identified in some way with the fauna or flora of Australia were presented during the year, and are now on view—one of Professor Herdman of Liverpool University, the gift of Mr. C. Hedley; the second of the late Rev. Dr. Woolls, well known to, and highly venerated by, the older botanical members of the Society, for some years a contributor to our Proceedings, for which the Society is indebted to the Trustees of the Australian Museum; and the third, of the late Alexander Walker Scott, formerly of Ash Island, author of "Australian Lepidoptera," and an active member of the Entomological Society of New South Wales, a donation from the Secretary. It is very gratifying to have the Society's collection of portraits added to in this interesting and very welcome manner.

Dr. E. Mjöberg, of Stockholm, has been good enough to send to the Society reprints of eleven papers published in the Handlinger[Bd. lii., 1913-15] or in the Arkiv för Zoologi[Bd. ix., 1915] of the Royal Swedish Academy—a first instalment of a series entitled "Results of Dr. E. Mjöberg's Swedish Scientific Expeditions to Australia, 1910-13." Six authors have co-operated in the production of these papers, which deal with the Mammals, Reptiles, Batrachia, certain groups of Hymenoptera [Fam. *Stephanidæ*, *Ichneumonidæ*, *Braconidæ*, and *Formicidæ*], and some Mesozoic plants. A number of species are described as new, and many notes on geographical distribution and on other matters are given. When completed, the series promises to be a very important contribution to a knowledge of the fauna of the outlying parts of Australia in which the collecting was done.

I am sure that I shall voice the sentiments of this Meeting in offering to two of our Members, who have given of their best at Gallipoli, sincere sympathy in their bereavement.

We have heard, with pleasure, during the year, of the appointments of two of our Members, both Members of the Council, also, to important positions in the Department of Mines—Mr. Cambage to succeed Mr. Pittman as Under Secretary; and Mr. J. E. Carne to the position of Government Geologist. On behalf of the Society, I would like to offer them our hearty congratulations on their promotion, and our best wishes for success in their new undertakings.

To Mr. J. H. Maiden, also, I would offer our cordial felicitations on his election to the Royal Society of London.

A noteworthy feature of late years has been the foundation of large numbers of Societies all over the world, having for their object the protection and preservation of the Flora and Fauna, of natural beauty-spots, and places or buildings with historical associations.

In England, the Selborne Society is doing valuable work in fostering the tendency towards caring for plants and animals. America has its Audubon and other Societies, and, in Australia, there are the Wild Life Protection Society, the Gould League of Bird-lovers, and the Australian Forest League.

The only way in which effective protection can be brought about is by educating the people, and leading them to see that it is necessary; and it is this method which is adopted by all these Societies. It is recognised by most of us that, to be lasting, such education should begin as early as possible; and, for this reason, the Gould League of Bird-lovers seeks to enroll the school-children. In this respect, the League has received the greatest encouragement and assistance from the Educational authorities. In our own State and in Victoria, that assistance has been particularly generous, and the results are very encouraging. In many country schools, the wild birds come no longer under that name, for they are almost domesticated; they come and feed

among the children at their lunches, and show little fear of those who, a few years ago, would have been their natural enemies.

A significant sign of the improvement in the public point of view in this matter, is the frequent discussions in the press, both daily and weekly, of the value or harmfulness of birds, We find nowadays, a great many people who will even say a good word for the once universally detested Crow. It is recognised that, black though he may be, he is by no means so black as he is painted. And it is beginning to be generally understood that, as Mr. W. W. Froggatt pointed out many years ago, a bird may be very destructive in one locality, and extremely useful in another. In the matter of official protection of birds, we are very far behindhand. The Act gives a long list of protected birds, under the scientific names. The police, who are charged with the administration of the Act, have not the necessary knowledge of the birds. The remedy would be an Act which listed the birds which might be shot, a suggestion which we also owe to Mr. Froggatt.

One method of encouraging the birds—the provision of nesting-boxes—does not meet with a great deal of success. Our native birds do not take to these. In both England and America, the providing of such boxes is much resorted to. There are many firms which make a specialty of manufacturing them, and the birds respond by using them freely. But here, we find that, as a rule, the only tenants are the sparrow and the starling. It may be that Australia's being so recently settled, the birds have not reached that stage of sophistication which would lead them to see the advantages of such shelter.

All this is a matter for congratulation to such Societies as ours. The plants and animals offer numberless, unsolved problems to the biologist, and their preservation is, therefore, a matter of grave concern. And, in Australia, it is of very great importance on account of the unique characters of the fauna and flora. We are offered numbers of biological problems for investigation, which from the nature of our fauna and flora, are of compelling interest. Yet it is a lamentable fact that not very

much has been done by Australian naturalists towards the solution of these problems. This is all the more regrettable, because, as a consequence of the rapid spread of settlement, and the increasing requirements of civilisation, many of our plants and animals are fast moving towards the limbo of lost things where they will meet with the Dodo, and the Great Auk. The spread of the cities and the operations of land-vendors are rapidly destroying our highly specialised, local flora; and, with the plants, the animals also disappear. And with them will disappear the opportunity for research into their bionomics. In the vicinity of all our towns, the flora is becoming a cosmopolitan one, and the Australian element forms but a small portion of it. It behoves us, then, before it is too late, to get to work on the bionomics of our native plants and animals.

A very important problem among these is the pollination of Australian flowers by birds. Looking into this question, on the suggestion of Mr. J. J. Fletcher, I was surprised to discover how little definite information on the subject of bird-pollination was to be found. The fact that a given species of bird visits a flower, is often taken as evidence that the flower is pollinated by that bird, but as to the method by which it is done, no record is made. Schimper(3) quotes Belts' description of the pollination of Marcgravia, and goes on: "Since Belt's classical description, and the unfortunately very short communications of F. Müller, the knowledge of humming-bird flowers has not made any considerable progress, for the surmises of several botanists formed far away from the home of humming-birds cannot be considered as such. The share taken by humming-birds in causing the peculiarities of many American flowers, can be ascertained only by careful and critical investigations on the spot." These remarks apply equally well to pollination by birds in Australia.

One of the first questions arising is, Are bird-pollinated flowers specially adapted in any way? Certainly many of them do present special features. Hermann Müller(2) says that ornithophilous flowers present several types. Many of them possess large, brilliantly coloured flowers, very frequently scarlet, pouched in

form, upright in position, and secreting a great abundance of honey. But Kerner(5) says that laterally directed flowers are visited solely by hovering visitors such as the owlet- and hawk-moths and humming-birds, which require no platform, and, therefore, none is provided. And he speaks of the absence of plates, ridges, fringes, pegs, or knobs in bird-pollinated flowers. From personal observation, I should think that a large number of them have pendent flowers, as in the Fuchsia and Abutilon. It is certain, too, that honey-eating birds will visit any type of flower that contains much nectar. Moseley(6) speculates whether the humming-birds of Juan Fernandez may not be the agents of pollination in the strawberries, cherries, peaches, and apples. It is certain that honey-eating birds will visit any flower, no matter what type, that contains much honey. Beal records the pollination of cherries and catmint, and red clover is recorded by another observer.

Still, there is no doubt but that the majority of bird-pollinated flowers are more or less tubular, are brilliant in colour, and contain much honey. Further investigation will result in other types being recognised, but the above is no doubt the commonest. It is remarkable how soon birds recognise suitable introduced plants. Our Australian honey-eaters regularly visit Hibiscus, Abutilon, *Tecoma capense*, and other species, *Bignonia venusta*, *B. radicans*, Pentstemon, Gladiolus, Honeysuckle, Cotyledon, Echeveria, and Agave, all eminently adapted to bird-visitors.

One fact that must not be lost sight of is, that flowers specially adapted for pollination by birds, are equally adapted for visits from hawk-moths, and other moths with long probosces. Bates(4) relates how he, several times, shot a moth instead of a bird, and says that the manner of flight and poise before a flower are precisely like those actions in a humming-bird. Only after some days was he able to distinguish the bird from the moth. He records, also, that the natives, and many of the educated whites, believed the moth *was* a bird. The daylight and crepuscular hawk-moths do frequent the same flowers, and are as successful in pollinating them, as the birds. I have observed that *Clero-*

dendron tomentosum is visited by the Spinebill in the daytime, and by hawk-moths in the evening and at night. But while the day-flying moths visit the same flowers as the birds, the night-flying moths would not visit the red flowers, for even by strong moonlight, the red colour would be invisible. The close resemblance of the moth and the bird is a very interesting example of how similar environment brings about analogous structure, and similar habits in very different organisms. A more curious instance of this is the fact recorded in Knuth(8), that a bat, in Trinidad, pollinates the flowers of a tree, behaving so like a moth that it was mistaken for one. It has a brush-like tongue like a humming-bird.

The profession of pollinator seems, in the main, to be confined to a few families of birds. In America, the humming-birds (*Trochilidæ*) and sugar-birds (*Cœrebidæ*) are chiefly concerned. In Hawaii, the *Drepanididæ* (35 spp. in 17 genera) and *Meliphagidæ* (5 spp. in 2 genera) are the agents. In Australia, we have *Meliphagidæ* (72 spp. in 23 genera), and 7 species of brush-tongued Lorikeets. Africa has its Sunbirds (*Cinnyridæ*) and Flower-peckers(*Dicæidæ*). In New Zealand, are the *Meliphagidæ* and a few parrots.

But there is no doubt that other birds, at times, pollinate flowers. Whether they visit the flowers in search of insects, or nectar, is not quite apparent. Moseley(6) gives an account of *Artamus leucopygialis* being shot, and found to have the bases of their bills clogged with pollen, which, he thinks, they got in searching flowers for insects. But Mr. Musson, in a letter to Mr. Fletcher, records that numbers of *Artamus personatus*, and *A. superciliosus* visited the flowers of a Beefwood (*Grevillea robusta*) and fed on the nectar. When some starlings visited the tree, the wood-swallows left, and the starlings began to feed on the nectar in just the same way. I have also been informed by several observers that sparrows probe the flowers of the Coral-tree (*Erythrina*) in the same way that the honey-eaters do. It is probable that closer inquiry into the habits of our birds will result in the discovery that many of them, while not professional

pollinators, yet do a good deal of that work as amateurs. Mr. North informs me that Black Cockatoos visit the heads of Banksia-flowers in search of honey, and, no doubt, often pollinate some of the flowers in doing so.

All the special pollinating birds have some peculiarities of structure, which fit them for the special work they have to do. The humming-birds are capable of poising on the wing before the flowers they frequent, their beaks are either long or short, slender, curved, and, in some cases, at least, specially adapted to pollen-carrying. In a paper by J. L. Hancock(7), he describes and figures the beak of a humming-bird, showing what he calls a "pollen repository"—a groove in the ventral surface of the bill, and grooves at the angle of the mouth, from the nostril on the upper side. He also describes feathers about the head apparently adapted for holding pollen. These have barbules with barbicels. The pollen-grains are held between two barbules, or the barbs spread apart, and hold pollen like a pair of forceps.

In a paper by Robert Ridgway(9), he describes the tongue of the humming-bird as follows: "The tongue of this species (and doubtless others have a similar conformation) presents, when recent, the appearance of two tubes laid side by side, united for half their length, but separate for the remainder. Their substance is transparent in the same degree as a good quill, which they much resemble. Each tube is formed by a lamina rolled up, yet not so as to bring the edges into actual contact, for there is a longitudinal fissure in the outer side running up considerably higher than the junction of the tubes; into this fissure, the point of a pin may be inserted and moved up and down. Near the tip, the outer edge of each lamina ceases to be convolute, but is spread out, and split at the margin into irregular fimbriæ which point backward like the vane of a feather. These are not barbs, however, but simply soft and flexible points, such as might be produced by snipping diagonally the edges of a strip of paper. I conjecture that the nectar of flowers is pumped up the tubes, and that minute insects are caught, when in the flowers, in these spoon-like tips, their minute limbs being perhaps entangled in

the fimbriæ, when the tongue is retracted into the beak, and the insects swallowed by the ordinary process, as doubtless those are which are captured by the beak when in flight."

Prof. Beal(11) gives the results of the investigations of some students into bird-pollination by humming-birds. They visit flowers for at least two objects, for insects and for nectar. Pollen-grains have been found on the bills and on the heads of the birds. They were seen to frequent pelargoniums, fuchsias, trumpet-creeper, phloxes, verbenas, catmint, milkweed, tropœolums, honeysuckles, lilacs, morning-glories, cherries, and wild balsam.

In the latter, the anthers form a covering to the pistil. If the flowers are covered up, no seed is produced. Humming-birds visited all the open flowers. Every time one plunged his beak in, the head, a little above the beak, became dusted with pollen. Where the anthers were removed, the birds left pollen on the stigma. All the flowers in one cluster were visited twice in 15 minutes. *Impatiens fulva* is cross-fertilised mainly, if not entirely, by humming-birds.

Trelease, in a note supplementary to Prof. Beal's(11), says the Ruby-throat is often seen to get nectar from both glands at the base of the cotton flowers. It was constantly seen at the flowers of *Oenothera sinuata*, very often about those of the may-pop (*Passiflora incarnata*), the white-flowered buckeye (*Aesculus parviflora*), the wild and cultivated morning-glories, yellow day-lily, white oleander, several sorts of pelargonium, lemon, fuchsia, larkspur, malaviscus, zinnia, sage-bush, osier-willow. One was seen at the flowers of gourd, and several times at flowers of *Lobelia cardinalis*, where they usually acted as the one spoken of in American Naturalist, 1879, p.431. Flowers of *Erythrina herbacea* were often visited, and they appear to be adapted for fertilisation by them like the Palosabre in Belt. According to Gould, to number all the flowers visited by them would be equivalent to repeating the names of half the plants of North America. The same author also gives an account(11) of the fertilisation of *Salvia splendens*. One of the flowers visited had

the stigma closed. The lever of the connective was nearly an inch long.

In "The Fauna Hawaiiensis"(10), Perkins gives a long account of the pollination of endemic flowers by native birds belonging to the Families *Drepanididæ* and *Meliphagidæ*. The former contains thirty-five species in seventeen genera, and the latter five species in two very distinct genera. The birds of the first family vary from entirely honey-eating to entirely insect-eating, and the *Meliphagidæ* appear to be entirely honey-eating. All the *Drepanididæ* have the tubular tongue, which shows descent from a common ancestor; and the author considers that that ancestor was a honey-eater, but that, as insects became more common, the characters of some of the birds gradually altered. He states that nectar is absolutely necessary to the existence of five of the genera, and that these can be kept alive on nectar and sugar-cane juice. The nectar-feeding birds are characterised by a slender beak, as well as the tubular tongue. "All, or practically all, the plants visited by these birds for food had bell-shaped or tubular blossoms, in which nectar was more or less hard to reach. Of these tubular-flowered plants, there are several predominant genera, some of which are themselves restricted to the islands, and belong to various families, comprising hosts of peculiar species. Most striking of all are the arborescent Lobeliaceæ, not closely related to forms found in other countries. The multiplicity of these plants, and their isolation from foreign forms bears a striking resemblance to that of the Drepanid birds themselves, indicating likewise an extremely ancient occupation of the island." This seems to me to show that the flowers (Lobeliacea) and the birds developed in dependence upon each other, and the author holds the same view, for he says:—"How easily the extraordinary lengthening of the bill . . . . . may have taken place, side by side with the increasing length of the tubular flowers, is apparent from the fact that, even now, in some of the birds, there is individual variation in this respect. . . . A series of observations made on one of the most superb of the Lobelias showed that it could only be fertilised by these highly specialised

birds." It is much to be regretted that Mr. Perkins does not give full particulars of these observations. Just as in many other cases, we have no information beyond the fact that the birds visit the flowers.

A note of interest is to be found in the method employed by the hunters in the old days for taking *Drepanis pacifica*—the Mamo—the bird from which the yellow feathers used in the ancient feather-work was procured. The hunter covered himself with the branches and leaves of a tubular-flowered plant, and held, between finger and thumb, one of the flowers. When the bird inserted its bill, he closed his finger and thumb together, and thus captured it. The birds and flowers of Hawaii offer a unique opportunity to a field-naturalist to enrich our knowledge of bird-pollination.

Scott Elliott has published two papers on bird-pollination in South Africa(12). He mentions *Protea incompta*, *P. mellifera*, *P. lepidocarpa*, *P. longifolia*, *P. grandiflora*, *P. cordata*, *P. scolymus*, *Leucospermum conocarpus*, and *L. nutans* as being fertilised by the birds *Promerops cafer* and *Nectarinia chalybea*.

Bertha Stoneman, in her bright little book on South African plants and their ways, mentions the pollination of Gladiolus and Loranthus by the Nectariniæ. But no details as to method are given.

A good deal of observational work has been done in New Zealand on pollination by birds. Darwin(14) quotes Potts (Trans. N.Z. Inst.) as follows: "In New Zealand, many specimens of the *Anthornis melanura* had their heads coloured with pollen from the flowers of an endemic species of Fuchsia." Wallace gives a list of Australian and New Zealand flowers pollinated by birds(15), and says, "The great extent to which insect and bird agency is necessary to flowers is well shown by the case of New Zealand. The entire country is comparatively poor in species of insects, especially in bees and butterflies, which are the chief flower-fertilisers; yet, according to the researches of local botanists, no less than one-fourth of all the flowering plants are incapable of self-fertilisation, and, therefore, wholly dependent on insect and bird agency for the continuance of the species."

Thomson(16) gives a good account of the pollination of the Glory-pea (*Clianthus puniceus*). The birds concerned are the Tui, and the Korimako. The calyx of the flower contains a large drop of honey. Birds, in inserting their beaks, push back the carina, and this retains its hold of the style for a considerable time, till the pressure becomes too great, when the latter is jerked forward by its own elasticity, and throws out the accumulated pollen on the intruder's head. Of *Fuchsia excorticata*, *F. Colensoi*, and *F. procumbens*, he says that each species is dimorphic. The larger forms are green and purple, with exserted anthers. Both forms are scentless, but contain much honey. They appear to be fertilised by Tuis and honey-birds. The flowers are pendulous, affording no resting-place for insects, and have so large a quantity of honey that any insects, except long-tongued forms, would be drowned. Kirk(17) says *F. excorticata* and another species which he does not name, are *trimorphic*, and that, in the latter species under cultivation, the mid- and short-styled forms are certainly self-fertilised. But in *F. excorticata*, "the entire work of fertilisation is effected by two forms only; the long-styled can exercise no influence on the fertilisation of other flowers; it is a female flower, and, therefore, must receive pollen from the mid- or short-styled form, or from both. It is, therefore, remarkable, that long-styled flowers produce fruit in greater profusion than the mid- or short-styled. In the absence of experiments, it would be rash to assert that the short- and mid-styled forms are incapable of fertilisation, but there can be no doubt that the application of pollen of either form to the stigma of the other would result in the formation of large numbers of seeds. . . . . The short-styled form may occasionally be self-fertilised, as detached pollen falling from its stamens may come in contact with the sides of its stigma. Birds are the usual agents for the transfer of pollen from one plant to another. It is interesting to watch them poising on the wing and dexterously inserting their beaks into the slender tube of the flower." Thomson also enumerates, as bird-pollinated, the following—*Sophora tetraptera*, chiefly visited by honey-birds

(another visitor will be mentioned later); *Metrosideros lucida*, probably fertilised by Tuis and honey-birds, which, in great numbers, frequent them; *M. hypericifolia*, sometimes visited by birds; *Loranthus colensoi*, scarlet flowers, no scent or honey, but this is probably developed at some period of growth, and it then attracts Tuis and honey-birds; *Phormium tenax* is chiefly fertilised by birds. Insects may visit the flowers, but they depend upon Tuis and honey-birds. Kakas and parakeets also aid sometimes.

Petrie(18) gives an account of the pollination of *Vitex lucens*. "There is no doubt pollination is effected exclusively by small birds. These constantly visit the flowers, hanging on the rigid leaf-stalk or flower-stalks, and insert their bills into the corolla-tube to suck the nectar. In sucking the sweet juice, the Tui may be seen grasping the flower in one foot and turning it round into a more convenient position. In passing from flower to flower, the birds cannot avoid bringing pollen from young flowers to older ones." In an earlier volume(18), he refers to the pollination of *Rhabdothamnus Solandri* as being effected by birds, and notes that the flowers are orange striped with red.

Kirk(17) quotes a description of Colenso's of the pollination of *Sophora tetraptera* by the New Zealand parrot (*Nestor meridionalis*) as follows:—"Close to the village, and even within its fence, were several large Kowhai trees; these were covered with their golden flowers, and mostly without leaves. . . . . The parrots flocked screaming to the Sophora blossoms. It was a strange sight to see them; how deftly they managed to go out to the end of a long, lithe branch, preferring to walk parrot-fashion, and there swing backwards and forwards, lick out the honey with their big tongues *without injuring the young fruit*. . . . I found that all the fully expanded flowers had had the upper parts of calyces and the uppermost petal (vexillum) torn out; this the parrots had done to get at the honey. As the flowers are produced in large, thick bunches, some are necessarily twisted or turned upside down; still it is always that peculiar petal and that part of the calyx (though often in such cases underneath)

which have been torn away. Through this, no injury was done to the young enclosed fruit, which would, in all probability, have been the case if any of the other petals had been bitten off."

Laing and Blackwell(19) refer to a number of plants already mentioned, and add *Knightia excelsa* as much visited by Tuis and bellbirds.

North's "Catalogue of the Nests and Eggs of Australian and Tasmanian Birds" gives a total of 67 species of honey-eaters and brush-tongued lories, but the author informs me that five species have been added to the honey-eaters since that section of his catalogue was completed. Add to these the Black Cockatoo, already referred to as visiting Banksia-heads, and we have 74 species, in 26 genera (though Matthews puts the Honey-eaters in 42 genera), all flower-frequenting in their habits. Both the Honey-eaters and the Lorikeets have their tongues markedly adapted to their nectar-feeding habits.

Von Mueller's "Second Census of Australian Plants" contains 8,581 species of flowering plants—a number which is now somewhat too small; but the records of new species are so scattered, that I have not attempted to arrive at the correct total. I have gone through the Census, and find that there are, at least, 649 species adapted to bird-pollination. This is no doubt under the real number; many of the plants are unknown to me; and I have also omitted the Styphelias, most of which are ornithophilous, because von Mueller has lumped several genera, such as Leucopogon, not ornithophilous, in that genus. But even so, this shows that about 7·4% of our flowering plants are ornithophilous. Of the 649 species mentioned, 385, or a good deal more than half, are Proteads, which are peculiarly adapted for bird-visitors.

Taking a smaller area, I am tolerably familiar with the plants and birds of the Mudgee district. In that district, there are 401 flowering plants, and of these 53 are ornithophilous, 14 being Proteads. Thus 13·2% of the flowering plants are adapted to birds. There are 194 species of birds, of which 23 are honey-feeders (13·3%), a rather curious coincidence. It can be seen,

then, that the birds and flowers which are dependent on each other form a large percentage of the avifauna and the flora.

We hardly expect to find references to bird-pollination in Gould's "Birds of Australia." But we do find numerous allusions to the nectar-feeding habits of the honey-eaters; and he also repeatedly states that they eat pollen, giving instances of pollen being found in their stomachs.

The earliest reference, which I can find, to the pollination of Australian flowers by birds, is in an article on Eucalyptus by Dr. Woolls(1). Speaking of hybridisation in *E. tereticornis*, he says, "With regard to hybridisation in this genus, the flowers of which are probably fertilised before the operculum is cast off, Dr. Mueller does not think that it is impossible, but that all ordinary chances are against it. 'Still,' he continues, 'as Mr. W. S. Macleay remarked, parrots and other birds occasionally bite off the flower-buds, and may accidentally uncover a stigma, and remove the anthers; and, again, insects may then finish off their work, and carry pollen across from another species."

A correspondent, Mr. S. T. Turner, in a letter, mentions that, at the time of writing, parrots were very busy biting off the opercula of Encalypt-buds.

I do not think that there is any foundation for the opinion that Eucalypt-flowers are fertilised in the bud. They are conspicuous flowers when open, scented, and contain a large amount of nectar, all of which would point to pollination by insects or birds.

I have not been able to trace any further allusion to bird-pollination in Australia until 1895, when a couple of short notes by myself were read at a Meeting of the Australasian Association for the Advancement of Science(20). These recorded the visits of Acanthorhynchus, and a species of Ptilotis to *Erythrina indica*, and of Acanthorhynchus to Telopea. In neither was the process described, but it was in a later paper(21). In Erythrina, the flowers are curved towards the left, and the bird sits on the right-hand-side, and inserts its beak into the other side. The pressure forces the stamens and style out, so that they brush on the side of the bird's neck, leaving a deposit of pollen. Should the bird then

visit a flower in which the stigma is receptive, some pollen would undoubtedly reach it. I captured a bird while feeding, and found a considerable smear of pollen on the neck. As a rule, birds feeding on nectar allow a much closer approach, and it seems also as if they lost some of their fear of man; for when I held a blossom to the bird in my hand, it inserted its bill, and fed on the nectar. I have seen a note on honey-eating birds stating that they may become intoxicated with the honey, and even drop to the ground at times, but, unfortunately, I omitted to record the reference. There is no doubt, however, that some flowers produce nectar which is more or less intoxicating. That of *Banksia ericifolia* is so, and is apt to produce, a severe headache in some people. Although the birds were most assiduous in their attentions to the trees I had under observation, no fruits were produced. I carefully pollinated a large number of flowers, and found that the fruit developed till it was four inches in length, and as thick as a knitting needle, but at this stage it invariably dropped off. Hermann Müller(2) says that Darwin states, on the authority of MacArthur's Observations that, in New South Wales, Erythrina does not produce good fruit unless the flowers are shaken. But the late Mr. G. H. Cox told me that it bore seed freely at Mulgoa. And I have been told that it seeds plentifully on the Northern Rivers and in Queensland.

The Note on Telopea states: "The flowers produce very large quantities of nectar at certain stages, so that if a head is shaken, a shower of drops is thrown off. They are much visited by Acanthorhynchus and other honey-eating birds, yet they rarely produce fruits; but when a plant does, it usually develops a large number. In one instance, I observed a head which was much damaged by some larvæ, and this head afterwards developed several capsules." Later I was able to watch one of these birds at a head, which was in the nectar-bearing stage. I could not get close enough to see just where the pollen was deposited on the bird, but I marked the plant, and afterwards found eleven capsules on it.

Holtze(22) gives the following account of the pollination of *Grevillea chrysodendron*:—"The showy flowers of this species are

closely packed into the form of a brush, and abound in nectar. Before maturity, the long pistil is curved, so that the stigmatic point is inserted between the anthers at its foot. At maturity, the pistil becomes erect, bearing on its head the pollen deposited there by the anthers. The tree is visited by a small bird for the nectar in the flowers, and the pollen is taken from tree to tree on its breast and head, which come into contact with the stigma in probing for the nectar. Cross-fertilisation, therefore, is facilitated, and the existence of the provision for the pollen being deposited naturally on each stigma would lead one to expect that, in the ancestral form, this was to insure fertilisation should the flower not receive pollen from elsewhere. However, in the species under notice, the flowers appear to be incapable of fertilisation with their own pollen." The writer makes the common mistake of supposing that the whole of the disc on the end of the style is stigmatic, but this is not so. The stigma is a minute, nipple-like point in the centre, and in no species of Protead have I ever seen pollen on this.

Dr. Shirley, in the same volume(23), has a paper on "Peculiarities of the Flowers of the Order Proteaceæ," in which he says, speaking of Grevillea: "The lowest have styles with a true stigmatic surface. The central ones have immature styles coated with pollen. The apical ones are still hooked in the perianths, and, where the style-end is adherent to the petals, are clothed round the line of attachment with a copious supply of honey. Parrots and honey-eaters frequent the plants at this and earlier stages, clinging below the flowers, and reaching to the apex of the inflorescence where most honey lies. In doing so, they brush the pollen from the central flowers on their feathers, and, visiting the next branch, attach the grains to the lower stigmas of the next inflorescence, thus fertilising them." He also notes the small proportion of fruits that are sometimes found: "That this apparatus often fails is seen in the few perfect fruits on Hakea and Macadamia bushes which have borne masses of blossoms, and by there being seldom a dozen fruits on a Banksia-cone, which carried a thousand perfect flowers."

With the assistance of some students, I investigated a bush of

Banksia ericifolia. We found that the average number of flowers on a head was 900. Then, taking all the heads more than one year old, we found that only 0·01 per cent. of the flowers had developed fruits. Usually one finds a large number of old cones without a single fruit, and then one with from twelve, up to twenty. In one instance, we found forty fruits on a single head. I attribute this to the fact that, when the birds find a head with plenty of nectar, they work over it again and again. In West Australia, I noticed that the Banksias about Perth bore comparatively few fruits, while those round about Albany fruited very freely. This arises, I think, from the fact that the honey-eaters are much more plentiful at the latter place, and perhaps also from the presence of Tarsipes, which is still found in that neighbourhood.

Mr. Musson and Mr. Carne have been good enough to supply me with some interesting observations on bird-pollination, but, unfortunately, I have mislaid their very accurate series of notes on the pollination of *Grevillea robusta*, illustrated with photographs. The notes showed that the flowers, at different stages, took up different positions, and that these changes were related to the habits of the birds in visiting the blossoms. I hope Messrs. Musson and Carne have copies of these notes, as they certainly should be published, and would form a notable addition to our knowledge of bird-pollination in Australia. In one of Mr. Musson's notes, he says the Silver-eyes come to the underside of the horizontal spike of flowers by swinging the body round to get at the nectar. He also mentions the bees, and a moth, apparently a species of Agrostis, frequenting the flowers. Another interesting observation was made at Lindfield. An Acacia, probably *A. suaveolens*, was infested with numbers of the Berry-scale (*Lecanium baccatum*), and these excreted large drops of honeydew. Two individuals of the tufted honey-eater, *Ptilotis auricomis*, were seen feeding on the drops of sweet fluid. None of the scales were damaged; the birds were undoubtedly after the honeydew. This is an interesting observation, as it shows that the Meliphagidæ will go to any sweet fluid they detect. It is tolerably certain, therefore, that they will visit nectar-bearing flowers which they cannot pollinate.

While on the subject of the Proteads, I may mention that, as long ago as 1882, Trelease(24) made out, from the examination of plants growing in the Botanic Garden in Cambridge, Mass., the structure and mode of pollination of *Hakea nodosa*, and of *Grevillea Thelemanniana*. He notes that both flowers are incapable of self-pollination, and that the Hakea is probably pollinated by birds or insects, and the Grevillea by birds. He also refers to Kerner's guess as to Dryandra being pollinated by kangaroos.

Mr. O. Sargent has published a paper, "Biological Notes on *Acacia celastrifolia*(25). This plant (which Bentham considers a variety of *A. myrtifolia*), when the racemes open, secretes from the gland on the phyllode at the base of the raceme, a drop of nectar, and continues to do so all through the time of flowering. The Silver-eyes feed upon this. "Careful examination of a flowering-branch shows it to be well adapted for bird-pollination. No hindrance is offered to the bird, as the saucer of nectar stands open beside the inflorescence; yet in sipping the sweet fluid the bird is sure to brush against the fluffy blossoms, and have its feathers dusted with pollen. The next flower brushed against will receive some of this pollen on its stigmas."

Mr. Sargent has also been good enough to send me a copy of his MS. of a paper entitled, "Fragments of Westralian Plant-Biology," which has been accepted for publication by a Botanical Journal. The first part of this paper is concerned with ornithophylly. He thinks it probable that the flowers suited for birds have been evolved from entomophilous flowers. The Honey-eaters are aggressive feeders; if the nectar is not easy to get at, they rip the flower open. In that way, the flowers which were best suited to birds may have persisted, and developed, while the others retrograded. He sets forth certain types of flowers as being suited for bird-pollination, beginning with simple open flowers like those of Nuytsia; the flowers are open, and grow in masses; and birds feeding on them, as they do, cannot fail to pollinate the stigmas. Another flower of this type is *Xanthorrhœa Preissii*, and he has frequently seen small birds drinking the nectar. My son has seen the New Holland Honey-eater feeding on *X. hastilis*, following the

spiral of flowers round the spike. But as Mr. Sargent remarks, many insects also visit these. Indeed they are of a type visited by all sorts of insects.

The next type is *Loranthus linophyllus,* a tubular flower. It is visited by *Zosterops Gouldi.* Next comes Acacia, already referred to, and then Eucalyptus. Mr. Sargent estimates that *E. macrocarpa* has 1,400 stamens, and these form a band, one inch wide, and 5½ inches in circumference. The stigma is less than 1 mm. in diameter, so that the pollen-bearing surface was 3,000 times the area of the pollen-receiving surface. In the case of this species, he has not seen birds pollinating it, but has observed *E. redunca* and *E. calophylla* being visited by *Zosterops Gouldi,* and species of Glyciphila. From my knowledge of Eucalypt flower-structure, I should be more inclined to look upon the brush-tongued lories as, to use Mr. Sargent's phrase, the "official" pollinators.

In *Beaufortia sparsa,* he sees another type, more specialised for birds; and he has observed that the anthers rub against cheeks, foreheads, and throats. This type reaches further specialisation in *Calothamnus sanguineus.* In this, the anthers are arranged in bundles, so placed that they press against the heads of the birds (Glyciphila and Zosterops) visiting it. Other flowers mentioned as ornithophilous are *Astroloma divaricata* and *Blancoa canescens. Anigozanthos humilis* and *A. Manglesii,* he has not personally seen visited by birds, but his brothers have seen them at the former, and some friends have seen small birds at the latter. I may say that I have repeatedly seen Acanthorhynchus feeding on *A. Manglesii* in the King's Park in Perth, and I noted their black heads covered with yellow pollen.

Mr. Sargent names three of the Papilionaceæ as ornithophilous —*Templetonia retusa, Crotalaria Cunninghamii,* and *Clianthus Dampieri.*

His last type embraces the Proteaceæ, and he mentions *Adenanthos cuneata, Banksia attenuata, B. Menziesii, Dryandra floribunda,* and *D. cardnacea.*

Miss Brewster lately read a paper(26) before this Society on bird-pollination in *Darwinia fascicularis.* The paper is now

available to Members, so I need not quote from it. Miss Brewster has done an excellent piece of work, and left little, if anything, for others to glean, except to extend her observations to the other species of the genus.

A little book by Mr. C. Mudd(27) contains a good deal about pollination, some of it very extraordinary, too extraordinary to be taken seriously—as for example the pollination of Dryandra by kangaroos, said to have been observed on the Blue Mountains; and of an orchid by frogs.

In a paper by E. W. Berry(28), on "The Affinities and Distribution of the Lower Eocene Flora of South-Eastern North America, he gives a list of plants, among which are six Proteads in four genera – Palæodendron, Proteoides, Knightophyllum, and Banksia. He also mentions Banksia and Dryandra as being found in abundance in the European Tertiary, and that the family enjoyed a more or less cosmopolitan range in the Early Tertiary. The ancestors of the family, he thinks, probably entered the Australian Region during the Upper Cretaceous, before the country had become entirely separated from Asia, becoming adapted to the peculiar soils and climate of Australia: while the stock in the Northern Hemisphere appears to have been unable to stand the climatic changes, and thus became extinct. Von Ettingshausen, in his Memoir, republished by the Department of Mines, Sydney(29), described a number of Proteads from the Tertiary of Australia. Incidentally, I would like to place upon record my feeling that it is unsafe to identify plants from mere impressions of their leaves. The more plants I know, the more I find that leaves very similar occur in plants belonging to widely separated families, while, on the other hand, plants belonging to the same family, or even the same genus, may have leaves so utterly dissimilar, that I should hesitate, without having seen flowers or fruits, to think they were allied. The differing types of leaf in Banksia and Hakea are examples of this. But Mr. Deane expressed similar opinions from this Chair long ago, in much more convincing terms.

The point I wished to draw attention to is this: that the majority of recent Proteads are bird-pollinated, and specially

adapted to that. Now were these old Proteads (and notwithstanding what I have said above, I believe that there were archaic Proteads) bird-pollinated, and if so, what were the birds concerned? If an inflorescence of a fossil Banksia is known, it might be easy to say whether it was likely to have been so pollinated. And, in that case, I should like to ask the palæontologists whether there are any Tertiary birds known, which would be likely to have been the ancestors of any of the three great groups of pollinators– Humming-birds, Sun-birds, and the Honey-eaters of Australia?

I have said enough to show that the bird-pollination of Australian flowers is a large and interesting problem awaiting solution in detail. Some of the questions that need answering are the following. Are the colours of the flowers adapted to attract birds? It is generally taken for granted that bird-pollinated flowers are of brilliant colours, mostly reds. But closer acquaintance with the habits of the birds leads one to think that the brilliant colours may not be necessary to attract them. Our honey-eaters seem to visit any flower that offers them a plenitude of honey. Again, are the tubular flowers specially adapted to birds with long bills like the Meliphagidæ? Here, I think the answer will incline towards the affirmative, but nevertheless the fact that they go to shallow flowers, like Eucalyptus and Xanthorrhœa, seems to point to the same conclusion—that the shapes of flowers do not matter greatly, if there is abundance of nectar. Are there any other factors that are significant—scent, for example? These questions can only be finally settled by long-continued observation of the birds and the flowers they frequent.

The next point (or perhaps it should be the first) to be settled is the actual method of pollination. Knuth(8) says:—"It must be the aim of research in pollination to make out the adaptation of all flowers and their pollinators, and this can only be approached if such investigations are systematically carried out, and in as many small and clearly demarcated areas as possible." Now the points regarding adaptation which have to be observed are many. The shape and colour of the corolla, the presence and amount of nectar, the scent, the length and position of the stamens and style, at various stages of anthesis, the time of

maturation of anthers and stigma, and the relation of these stages to the changes of position in those organs. And, in the case of the birds, the presence of grooves on the beak as pollen-receptacles, the presence of modified feathers for the purpose of retaining pollen-grains, the position the bird takes on approaching the flower, and on what part of the body it receives and carries pollen; all these points must be made out before it can be said that we know how a flower is pollinated by birds.

To succeed in such an inquiry, the observer must have unlimited time and patience. He may have to sit motionless for a long period near the plant being investigated, till the birds gain confidence and approach the flowers; he must have keen sight and a good pair of field-glasses. He needs to camp out in a selected spot, and to be abroad at dawn, when the birds are beginning to feed; and, in addition, since the most precise information is necessary with regard to the bird's size, shape of head and beak, and their relation to the parts of the flower, and can only be seen in the bird in the hand, which is proverbially worth two in the bush, he must, repugnant as it may be to a bird-lover, be prepared to sacrifice the lives of some of the pollinators to settle these questions accurately. It is a big piece of work, but it is worth the trouble; and a few earnest investigators with sufficient time at their disposal would soon produce results which would be of far greater value than the vague statements to be found in most of the papers on bird-pollination. It is not that the interest and importance of the subject are unrecognised, but that favourable conditions for carrying out the necessary investigations have been wanting.

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Mr. J. H. Campbell, Hon. Treasurer, presented the balance sheet for the year 1915, duly signed by the Auditor, Mr. F. H. Rayment, F.C.P.A., Incorporated Accountant; and he moved that it be received and adopted, which was carried unanimously. *Abstract:* General Account, Balance from 1914, £531 13s. 4d.; income, £1,164 8s. 8d.; expenditure, £912 8s. 10d.; transfer to Bookbinding account, £5 5s. 0d.; balance to 1916, £778 8s. 2d. Bacteriology Account, Income, £527 17s. 6d.; expenditure, £535 7s. 2d.; debit balance to 1916, £25 19s. 9d. Linnean Macleay Fellowships Account, Income, £2,027 15s. 3d.; expenditure, £1,598 17s. 0d. (including £97 2s. 0d. for publication of Fellows' contributions to the Proceedings); transfer to Capital account, £428 18s. 3d.

No valid nominations of other Candidates having been received, the President declared the following elections for the Current Session to be duly made:—President: Mr. A. G. Hamilton. Members of Council (to fill six vacancies):—Messrs. R. H. Cambage, F.L.S., J. H. Campbell, H. G. Chapman, M.D., B.Sc., J. B. Cleland, M.D., T. Storie Dixson, M.B., Ch.M., and A. F. Basset Hull. Auditor: Mr. F. H. Rayment, F.C.P.A.

On the motion of Dr. S. J. Johnston, a very cordial vote of thanks to the President, was carried by acclamation.